

Name\_

## **Student Worksheet**

Record the color of each solution then refer to the indicator chart to determine the pH range for each of the added indicators.

## Data Table

		Cl <sub>3</sub> CCOOH	ClCH <sub>2</sub> COOH	CH <sub>3</sub> COOH
Methyl Red	Color			
	pН			
Bromphenol Blue	Color			
	pН			
Orange IV	Color			
	pН			
Universal Indicator "Rainbow Acid"	Color			
	pH			

## **Indicator Chart**

Indicator		Acid Color	Transition Color	Base Color
Methyl Red	Color	Red	Peach or Orange	Yellow
	pН	<4.8	4.8–6.0	>6.0
Bromphenol Blue	Color	Yellow	Olive Green	Blue/Violet
	pН	<3.0	3.0-4.6	>4.6
Orange IV	Color	Red	Peach or Orange	Yellow
	pН	<1.4	1.4–2.8	>2.8
Universal Indicator	Color	See Chart		
	рН	1–7		

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## Questions

1. Based on your observations, what range of pH values does the half-neutralized acetic acid solution fall into? What is the range for the half-neutralized chloroacetic acid solution? For the half-neutralized trichloroacetic acid solution?

2. For a weak acid (HA),  $K_a$ , the dissociation constant, is equal to:

$$K_{a} = \frac{[H^+][A^-]}{[HA]}$$

The pH of a weak acid solution can be expressed as the Henderson-Hasselbach equation:

$$pK_a + \log \frac{[A^-]}{[HA]}$$
 Equation 2

For weak acids with  $K_a$  values of  $1 \times 10^{-2}$  or less, at half-neutralization the conjugate base concentration, [A<sup>-</sup>], is essentially equal to the weak acid concentration, [HA]. Equation 2 becomes

 $\begin{array}{ll} \mathrm{pH} \ = \ \mathrm{p}K_{\mathrm{a}} \ + \ \mathrm{log}(1) & \mbox{ or } \\ \mathrm{pH} \ = \ \mathrm{p}K_{\mathrm{a}} \end{array}$ 

The  $pK_a$  for the 3 weak acids are:

	pK <sub>a</sub>
Acetic acid	4.75
Chloroacetic acid	2.85
Trichloroacetic acid	0.70

Do your pH range estimations agree with these values? If not, what are some possible explanations?